

GAO

Report to the Chairman and Ranking
Republican Member, Subcommittee on
Investigations, Committee on Armed
Services, House of Representatives

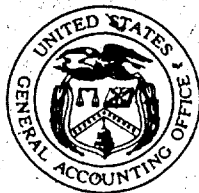
May 1992

COMANCHE HELICOPTER

AD-A253 420



Program Needs Reassessment Due to Increased Unit Cost and Other Factors



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United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-247939

May 27, 1992

The Honorable Nicholas Mavroules, Chairman
The Honorable Larry J. Hopkins
Ranking Republican Member
Subcommittee on Investigations
Committee on Armed Services
House of Representatives

In response to your request, we have reviewed the development of the Army's Light Helicopter, known as the RAH-66 Comanche helicopter. This report includes recommendations to the Secretaries of Defense and the Army.

Unless you announce the contents of this report earlier, we plan no further distribution of it for 14 days from its issue date. At that time, we will send copies to the Chairmen of the Senate and House Committees on Armed Services and on Appropriations; the Director of the Office of Management and Budget; and the Secretaries of Defense and the Army. We will also provide copies to others upon request.

Please contact me at (202) 275-4141 if you or your staff have any questions concerning this report. Other major contributors are listed in appendix I.

Richard Davis

Richard Davis
Director, Army Issues

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Executive Summary

Purpose

Although undergoing many changes during the 10 years it has been in development, the RAH-66 Comanche helicopter (formerly the Light Helicopter) is the centerpiece of the Army's aviation modernization plan. When fielded, it is to replace Vietnam-era scout and attack aircraft that the Army considers incapable of meeting existing or future requirements. Concerned about program changes over the past several years and the reduction in the threat that the Comanche was designed to address, the Chairman and the Ranking Republican Member of the Subcommittee on Investigations, House Committee on Armed Services, asked that GAO review the Army's continued development of the Comanche. GAO's specific objectives were to assess the (1) expected capabilities and role of the Comanche, (2) changes in the estimated program cost, (3) program's planned reliability and logistical support goals, and (4) risks associated with the acquisition strategy.

GAO completed the fieldwork for this report in February 1992. At that time, the Army announced that it had restructured the Comanche program primarily because of affordability problems. The restructured program, among other things, changed the Army's acquisition strategy by extending the research and development phase through fiscal year 1997. GAO did not assess the restructured program. The acquisition strategy that was in place when GAO conducted its review is addressed in chapter 5 of this report.

Background

The Army expected to acquire a family of low-cost, lightweight helicopters that could perform several roles when it began development of the Comanche. One version, a single-seat aircraft, (1) was to have the capabilities needed for armed reconnaissance and attack missions and (2) was to complement and support the AH-64 Apache. The Apache is the Army's premier attack helicopter and the most expensive attack helicopter it has acquired to date. A second, less complex version of the Comanche was to perform utility missions.

In 1988, GAO reported that the Army had (1) eliminated the single-seat concept for a two-seat aircraft, adding weight and cost and (2) reduced the planned acquisition quantity from 4,292 in 1987 to 2,096 in 1988 by deleting all of the utility aircraft.¹ The Army had planned to begin buying the Comanche in 1996.

¹Light Helicopter Program: Risks Facing the Program Raise Doubts About the Army's Acquisition Strategy (GAO/NSIAD-89-72, Dec. 23, 1988).

Results in Brief

The Comanche's next-generation capabilities, such as its advanced avionics and targeting systems, are expected to significantly improve Army aviation for years to come. However, the distinction between the roles of the Comanche and the Apache attack helicopter is no longer clear. The Comanche will now equal or, in some cases, surpass the Apache's attack mission capabilities.

Furthermore, in contrast to the Army's original goal of developing a low-cost helicopter, the Comanche's unit cost in escalated dollars has increased by more than 40 percent since 1988. In fiscal year 1992 dollars, its unit cost exceeds that of the Apache by over \$1 million.

Moreover, the Army's maintenance requirements for the Comanche appear to be understated. If the maintenance burden is higher than the Army's current estimates, this could increase manpower requirements or reduce the number of planned flying hours.

After a decade of developing the Comanche, the Army continues to experience some technical risks in some of the aircraft's essential components. For example, the complex software for the mission equipment package is still under development. Some of the aircraft's desired capabilities will be significantly affected if these risks are not adequately resolved.

Several broader issues, such as a diminished threat, planned force reductions, and planned upgrades to other helicopters, will likely have a significant effect on the Army's requirements for the Comanche. These issues, along with the changes within the Comanche program, make this an appropriate time to reassess the Army's requirements for this aircraft.

Principal Findings

Comanche's Advanced Capabilities Are Expected to Improve Army Aviation, but Its Role Is Unclear

The Comanche's most notable features are to include advanced avionics and targeting systems, improved engines, and lower detectability. Collectively, these and other capabilities are expected to improve the Army's ability to operate on future battlefields.

The Army planned for the Comanche to complement the Apache, flying ahead of it to scout targets. This role has been blurred because the advanced attack capabilities planned for the Comanche will enable it to

perform the same missions as the Apache. Moreover, the Comanche is expected to have some capabilities that will be superior to those of the Apache. For example, it is expected to (1) conduct air combat using its gun or missiles; (2) detect targets at 40 percent greater range; and (3) achieve a cruise speed of 170 knots, compared with the Apache's 145 knots. Furthermore, while the Army expects the Comanche's improved reconnaissance capability to satisfy a longtime deficiency in this area, Apache personnel told GAO that the Apache was successfully used to conduct reconnaissance missions during Operation Desert Storm.²

Unit Cost of Comanche Has Increased by More Than 40 Percent Since 1988

The Army had justified the Comanche to Congress as an aircraft that would be relatively inexpensive to buy and maintain, but its estimated costs have increased significantly. Primarily because of the reduction in the planned acquisition quantity from 2,096 in 1988 to 1,292 in 1990, the estimated total program cost declined in escalated dollars from \$40 billion to \$35.4 billion. However, the estimated unit cost in escalated dollars increased more than 40 percent to \$27.4 million. In constant 1992 dollars, the unit cost of the Comanche is \$1.4 million higher than that of the Apache (\$19.1 million compared with \$17.7 million).

Maintenance Requirement Appears Understated

The maintenance needs of the Comanche could be higher than the Army's goal of 2.6 maintenance man-hours per flight hour, which it based, in part, on experience with less complex helicopters. The Department of Defense estimated that the maintenance burden could be as much as three times higher. Understating these needs could result in too few maintainers, which would require the Army to either add maintenance staff or reduce the aircraft's planned 2,200 flying hours per year. The reliability and availability of the Comanche is directly related to the Army's ability to maintain it.

Technical Risks Remain in the Program

Despite the Army's efforts to reduce the Comanche's technical risks, numerous risks still remain in the program. These include the mission equipment package (electronic components) and the targeting detection system. Failure to adequately develop the mission equipment package, for example, would significantly reduce the Comanche's capability to navigate

²Operation Desert Storm: Apache Helicopter Was Considered Effective in Combat, but Reliability Problems Persist (GAO/NSIAD-92-146, Apr. 20, 1992).

and communicate. If the Army produces the aircraft before resolving these technical risks, significant additional costs could be incurred later.

Impact of Broader Issues on Comanche Requirements

Several significant developments have occurred outside the program that affect the Comanche's requirements. First, the Soviet and Warsaw Pact threat, which the Comanche was to counter, has disappeared. Second, the Defense Department has proposed \$50 billion in defense cuts through 1997, increasing competition for funds among the military services. Third, the Army plans to add major enhancements to the Apache and some reconnaissance helicopters, costing billions of dollars. These factors, along with program changes, make this an appropriate time to assess the program's viability to ensure that any future decision to buy the Comanche will be appropriate.

Recommendations

The GAO recommends that the Secretary of Defense review the appropriateness of the Army's requirements for the Comanche program, especially in light of the rising unit cost, dwindling defense resources, diminished threat, the blurring of its distinct role with the Apache, and proposed upgrades to the existing helicopter fleet. Such an assessment, at minimum, should address (1) whether the Army can afford to buy and fully support the Comanche, (2) whether some or all of the ongoing Comanche research and development efforts should be continued if the Army does not buy the Comanche, and (3) what alternative plans exist to meet part or all of the needs that the Comanche is expected to satisfy if the Army does not buy the Comanche. GAO also makes several recommendations to the Secretary of the Army in chapters 4 and 5 that are intended to improve the development of the Comanche, should the Defense Department decide to continue with this program.

Agency Comments

As requested, GAO did not obtain fully coordinated Department of Defense comments on this report. However, GAO obtained oral comments on its work from representatives of the offices of the Under Secretary of Defense for Acquisition; Assistant Secretary of the Army for Research, Development and Acquisition; the Army Deputy Chief of Staff for Operations and Plans; and others. GAO has included their comments where appropriate.

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Abbreviations

DOD	Department of Defense
GAO	General Accounting Office
RAM	reliability, availability, and maintainability
TOW	tube-launched, optically tracked, wire-guided

Introduction

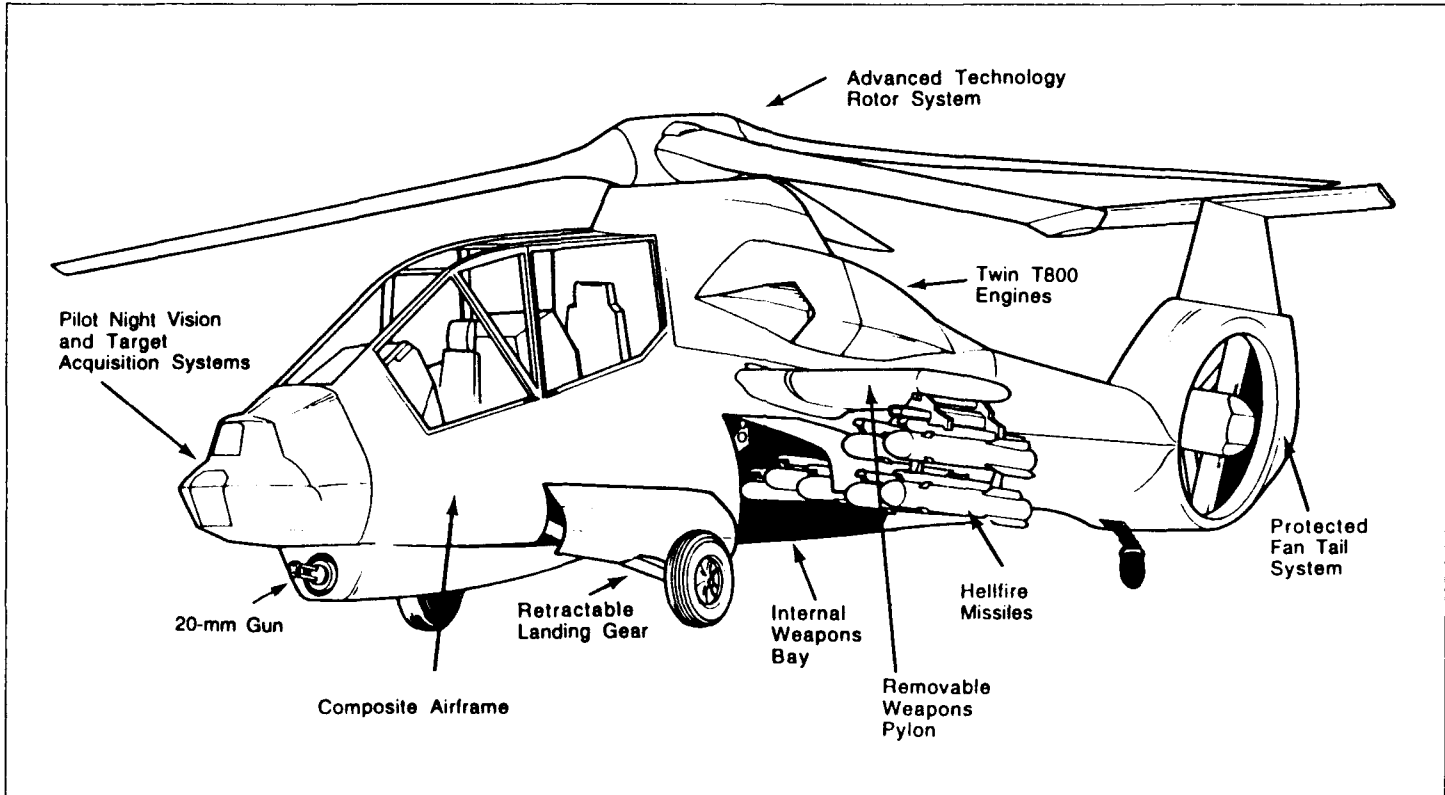
The Army is developing the RAH-66 Comanche helicopter as a fast, long-range, and agile aircraft to perform armed reconnaissance and attack missions. Formerly known as the Light Helicopter, the Comanche has been in development for 10 years. When fielded, it is expected to replace Vietnam-era scout and attack aircraft that the Army considers incapable of meeting existing or future requirements. The Army considers the Comanche the centerpiece of its aviation modernization program.

Comanche's Enhanced Features

The Comanche's most notable features include advanced avionics and target acquisition systems, a new engine, better maneuverability, and lower detectability. The next-generation avionics package is expected, among other things, to have the capability to more rapidly process navigational and other data, allowing the pilots to operate more efficiently. The target acquisition and night vision sensors are to be designed to provide greater range and higher resolution than those of current reconnaissance and attack helicopters.

The Comanche's twin engines are smaller than most current helicopter engines but are expected to provide greater power and be easily maintained because of a simplified design that requires fewer parts. The airframe will consist of about 55 percent composite materials instead of the metal construction used in older helicopters. Composite materials reduce the aircraft's weight, thereby improving its maneuverability. The Comanche also is expected to be more difficult for the enemy to detect, primarily because of various design features and new technological approaches. Figure 1.1 shows some of the Comanche's major components.

Figure 1.1: RAH-66 Comanche Helicopter (Attack Configuration)



According to the Army, these features will enable the Comanche to perform its reconnaissance and attack roles more effectively and provide greater firepower than the OH-58 Kiowa and the AH-1 Cobra, the two helicopters it is designed to replace. In its reconnaissance role, the Comanche is to locate and identify targets, provide targeting information for other attack helicopters, and report troop movements to field commanders. On attack missions, the Comanche is to use its advanced target acquisition systems to strike stationary and moving targets. It is also designed to operate close to the ground, using ground cover to mask its location, and to engage enemy helicopters in air combat.

Program History

In 1982, the Army identified numerous deficiencies in its existing aircraft fleet and recognized the need to develop a new aircraft that would incorporate capabilities to overcome these deficiencies. The Army determined, among other things, that the new aircraft should be able to

operate at night and in poor weather conditions; be lightweight; and perform utility, reconnaissance, and attack missions.

Following this assessment, the Comanche development program began as a family of aircraft in 1983. Since then, it has undergone several changes. The Army, for example, decided to build a two-seat aircraft (one pilot and one copilot/gunner) when preliminary research, in 1987, showed that the pilot work load posed by the mission requirements was too great for one person. Because of affordability reasons, the Army in 1988 dropped the utility version of the aircraft and also reduced the planned acquisition quantity from 5,023 in 1985 to 2,096. We reported on these and other changes in the program in three previous reports.¹ Our recommendations have included the incorporation of prototypes into the program and the postponement of full-scale development until the effectiveness of the prototypes could be demonstrated.

Program Status

In late 1988, the Army awarded competitive demonstration/validation contracts to two teams—(1) Boeing Helicopters Company, Philadelphia, Pennsylvania, and Sikorsky Aircraft Company, Stratford, Connecticut, and (2) Bell Helicopter Textron Company, Fort Worth, Texas, and McDonnell Helicopter Company, Mesa, Arizona—for the design of the aircraft. The purpose of this development phase was to establish design parameters and demonstrate the capabilities of certain components. The Army selected the Boeing-Sikorsky team in early 1991 as the winning contractor team and awarded it the demonstration/validation/prototype contract.

At the completion of our fieldwork, the Army had expected the procurement phase to begin in 1996 and extend through 2009, with a peak production rate of 120 helicopters per year. However, the Army announced in February 1992 that it had restructured the Comanche program. The restructured program would, among other things, extend the research and development phase, with no commitment to proceed to the procurement phase.

¹Weapon Systems: Issues Concerning the Army's Light Helicopter Family Program (GAO/NSIAD-86-121, May 22, 1986); Weapon Systems: Status of the Army's Light Helicopter Family Program (GAO/NSIAD-87-117FS, Mar. 13, 1987); and Light Helicopter Program: Risks Facing the Program Raise Doubts About the Army's Acquisition Strategy (GAO/NSIAD-89-72, Dec. 23, 1988).

Objectives, Scope, and Methodology

At the request of the Chairman and Ranking Republican Member, Subcommittee on Investigations, House Committee on Armed Services, we reviewed the continued development of the Army's Comanche helicopter program. Our objectives were to assess the (1) expected capabilities and role of the Comanche, (2) changes in the estimated program cost, (3) program's planned reliability and logistical support goals, and (4) risks associated with the acquisition strategy.

To determine the capabilities and role of the Comanche, we obtained and analyzed program documentation and interviewed officials in the Army's Comanche Program Manager's Office, Source Selection Evaluation Board, and other directorates within the Aviation Systems Command, all located in St. Louis, Missouri. We also analyzed documentation and interviewed officials from the Army Training and Doctrine Command, Fort Monroe, Virginia; the Army Aviation Center, Fort Rucker, Alabama; and the Army Combined Arms Command, Fort Leavenworth, Kansas.

To obtain the Comanche program costs, we examined the baseline cost estimate prepared by the Comanche Program Manager's Office and interviewed program officials. We also analyzed the Comanche's engine requirements to ascertain the costs associated with the engine procurement. In discussions with Comanche Program Manager's Office and Source Selection Evaluation Board officials, we identified items that would add to the aircraft's weight and cost requirements.

In examining the Comanche's reliability, availability, and maintainability and logistical support requirements, we reviewed Department of Defense (DOD) and Army regulations, Program Office documentation, and Army and contractor studies to determine how these requirements were established. We interviewed Army officials at the following organizations: the Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, Maryland; the Army Training and Doctrine Command; and the Army Aviation Center. We also interviewed DOD officials within the Defense Research and Engineering Directorate, Office of the Secretary of Defense.

To determine the risks regarding the acquisition strategy, we reviewed contracts, risk analysis reports, and other pertinent documents. We also interviewed officials in the Comanche Program Manager's Office, the Office of the Secretary of Defense, the Program Analysis and Evaluation Directorate, the Defense Research and Engineering Directorate, and the Offices of the Assistant Secretary of the Army for Research, Development and Acquisition and the Army Deputy Chief of Staff for Operations and

Plans. We reviewed documents prepared by the two competing contractor teams, the Source Selection Evaluation Board, and outside consulting firms. We also compared the acquisition plan and schedule to existing Army regulations and DOD instructions.

We conducted our review from October 1990 to February 1992 in accordance with generally accepted government auditing standards. As requested, we did not obtain fully coordinated DOD comments on this report. However, we did obtain oral comments on our work from representatives of the Offices of the Under Secretary of Defense for Acquisition; the Assistant Secretary of the Army for Research, Development and Acquisition; the Army Deputy Chief of Staff for Operations and Plans; and others. We have included their comments where appropriate.

Comanche's Attack Capabilities Emphasized While Its Role in Army Aviation Is Unclear

The Army has concentrated its design efforts on making the Comanche a sophisticated multi-mission aircraft with attack capabilities comparable to or more advanced than the AH-64 Apache—the Army's premier attack helicopter. As a result, the distinction in roles between the Comanche and Apache is no longer clear. Developments outside the Comanche program have made its role even less certain. These developments include a rapidly changing threat, a decline in defense spending, a reduction in forces, enhancements planned for other Army helicopters, and an evolving Army operational doctrine.

The Comanche's Overall Design Emphasizes Its Attack Mission

The Comanche represents the Army's first helicopter designed for attack, armed reconnaissance, and air combat missions. Although developed as a multi-mission aircraft, the Comanche will likely be the Army's most sophisticated and capable attack helicopter. Army officials told us, however, that (1) the same capabilities and features needed for an attack helicopter are also required for armed reconnaissance and (2) their most pressing battlefield deficiency is a lack of night and adverse weather reconnaissance, which the Comanche is to provide.

According to the Army, the Comanche will be superior to the OH-58A/C Kiowa reconnaissance and AH-1 Cobra attack helicopters. Improvements include significantly improved night and adverse weather capabilities and greater weapons loads. For example, the OH-58A/C and AH-1 have no adverse weather capability and limited night capabilities. The OH-58A/C have no weapons, while the AH-1 can be armed with tube-launched, optically tracked, wire-guided (TOW) missiles and unguided rockets. The Comanche will be able to carry up to 14 of the more advanced Hellfire missiles.

Nevertheless, our review shows that the Comanche's attack role has driven its overall design. Early program documents indicate that the Army identified the attack role (anti-armor) as the Comanche's primary mission. During development, the Army again emphasized the importance of the Comanche's attack capabilities. For example, the Army's decision to switch to a two-seat aircraft was prompted largely because one pilot could not successfully accomplish all of the tasks related to the attack mission. Studies indicated that available technology would not reduce the work load to an acceptable level so that a single pilot could fly the aircraft in combat, identify targets, and fire weapons at the same time.

Comanche Is Expected to Rival the Apache Attack Helicopter

As a consequence of the Army's emphasis on the Comanche's attack capabilities, the Army is developing an aircraft that is expected to be as capable as or more capable than the Apache. The Army believes that the Comanche will include improvements over the Apache, such as low-detectable materials; the ability to detect targets at 40 percent greater range; and a 170-knot cruise speed, compared with the Apache's 145 knots. Other improvements over the Apache include a second generation forward-looking infrared system for better identification of targets at night, reduced exposure times needed for target detection, and an improved flight control system.

When flying missions, such as armed reconnaissance, that emphasize low-detectable features, the Comanche is designed to carry up to 6 Hellfire or 12 Stinger missiles in internal weapons bays. For air combat missions, the Comanche, unlike the Apache, is designed to carry up to 18 Stinger missiles and employs a 20-millimeter gun (designed also for ground combat). The Comanche's state-of-the-art avionics are also expected to increase the combat effectiveness of the pilots over that of Apache pilots.

Approximately 2,800 pounds lighter than an Apache, the Comanche is also intended to respond to contingencies quicker. According to the Army, the smaller Comanche can be transported in aircraft ranging in size from the C-130 (carries one Comanche) to the C-5 (carries up to eight). After landing, the Comanche can be unloaded and readied for combat in about 20 minutes. Although the C-130 can carry one Apache and the C-5 can carry up to six, it takes over 3 hours to prepare the Apache for combat. The Comanche is to be able to self-deploy as far as 1,260 nautical miles, enough for overseas deployments. The Apache's self-deployment range is 990 nautical miles.

Distinction in Roles of Comanche and Apache Is Unclear

The Army planned for the Comanche to complement the Apache, flying ahead of it to scout targets. This role has been blurred because, given the advanced attack capabilities of the multi-mission Comanche, the Army can use it in the same missions as the Apache. For part of its combat force structure, the Army clearly plans to use the Comanche helicopter as an attack helicopter. The Army's fielding plan calls for at least 20 percent of the Comanche's force structure to be assigned, as attack helicopters, in light division attack battalions. This would place the Comanche in a role similar to that of Apaches assigned to attack battalions in heavy divisions. In addition, the Army expects that about 35 percent of its Comanches will scout for attack helicopters in light and heavy attack battalions. While

these helicopters would scout for the attack helicopters in the battalion, they could also perform armed reconnaissance and attack missions.

Because it is a multi-mission helicopter capable of conducting attack missions, the Comanche is expected to dramatically increase the lethality of both light and heavy division attack battalions. For example, if 25 Comanches with 250 Hellfire missiles replace 21 Cobras with 168 TOW missiles and 13 Kiowas in a light division, the Army estimates that the unit's lethality will improve by 49 percent. In a heavy division, if 10 Comanches and 15 Apaches with 340 Hellfire missiles replace 13 Kiowas and 18 Apaches with 288 Hellfire missiles, the unit's lethality would increase by 18 percent.

The attack capabilities of the Comanche are such that it could eventually replace the Apache helicopter. A 1986 Army report to the Senate Armed Services Committee states that "should the [Comanche] meet the Army's full expectations, [it] may well prove to be a viable alternative to eventually replace the AH-64 . . ." Moreover, the Army plans to incorporate the Longbow system—a fire control radar and improved Hellfire missile—on at least one-third of its Comanches. The Longbow system, which is also being developed for the Apache, should improve both aircrafts' ability to automatically classify, prioritize, and engage multiple targets.

Further blurring the distinction between the two aircrafts' roles was the Army's use of the Apache for long-range reconnaissance missions during Operation Desert Storm.¹ The Apache's primary mission is to attack heavy armored targets. Reconnaissance missions traditionally have been performed by low-cost, lightweight, and unarmed observation helicopters, such as the Kiowa. The Army confirmed after Operation Desert Storm that its observation helicopters lacked the capabilities needed to operate successfully at night, deep into enemy territory. The Apache was the only helicopter in the Army's inventory capable of providing long-range, armed reconnaissance.

¹Operation Desert Storm: Apache Helicopter Was Considered Effective in Combat, but Reliability Problems Persist (GAO/NSIAD-92-146, Apr. 20, 1992).

Developments Outside Comanche Program May Affect Program Requirements

Several broader issues may affect the Army's requirements for the Comanche. A significant development is the change in threat. The Soviet and Warsaw Pact threat, the threat the Comanche was originally intended to meet, has disappeared, and the future threat is unclear. The Secretary of Defense, in 1990, cited the reduced threat as a primary reason for decreasing the planned acquisition quantity by 38 percent. More recently, the Director of the Defense Intelligence Agency testified in January 1992 before the Senate Armed Services Committee that the Soviet military threat had profoundly declined and that, over the next 10 years, the most serious threats would be regional conflicts in the Middle East and elsewhere.

Another development that may affect the program is the planned reduction in defense spending and the resulting increased competition for research, development, and procurement funds. The President's fiscal year 1993 budget proposes \$50 billion in defense spending reductions through fiscal year 1997, and Members of Congress continue to debate whether further defense cuts will be necessary. According to a December 1991 Congressional Budget Office study, the Army's annual budget would have to increase in real terms between 2 and 4 percent between 1997 and 2003, without an increase in the size of the Army, in order to afford the Comanche and the Army's Armored Systems Modernization program.² At its peak, the annual funding for the Comanche could be \$2 billion or higher.

As part of U.S. defense force reductions, the Army is planning to reduce its helicopter fleet from about 8,600 to 5,600 aircraft, or almost 35 percent, by 2008, according to the Army's 1991 interim aviation modernization plan. In addition to replacing aircraft with the Comanche, the Army has proposed to spend billions of dollars to upgrade the combat effectiveness of its existing fleet:

- AH-64 Apache Longbow upgrade: The Army is planning to modify 227 Apaches—more than a quarter of the entire Apache fleet—with the Longbow system and make navigational, communications, and targeting improvements. The Army expects this upgrade to cost \$5.4 billion. In addition to the radar and missile system, modifications include a fully integrated cockpit to reduce pilot work load; an improved cooling system; expanded forward avionics bays; upgraded generators, batteries, and transformers for additional electric power; and an upgraded processing

²The Costs of the Administration's Plan for the Army Through the Year 2010, Congressional Budget Office staff memorandum (Dec. 1991).

system and new wiring for avionics. The Army expects these upgrades to significantly increase target acquisition efficiency, battlefield effectiveness, and survivability.

- AH-64 Apache basic upgrade: The Army plans to upgrade the rest of its Apache fleet to one or more advanced models. Possible improvements range from upgrades resulting from lessons learned in Operation Desert Storm to modifications similar to the Longbow configuration, but without the radar system. Upgrades may include navigational, communications, targeting, and survivability improvements; an air-to-air combat capability; and improvements to the 30-millimeter gun.
- OH-58D Kiowa Warrior upgrade: The Army has begun to upgrade part of its light observation helicopter fleet by arming and improving 243 of its OH-58D Kiowa helicopters. The Kiowa is currently equipped with a mast-mounted sight that includes a high-resolution television camera, infrared thermal imaging sensor, and laser range finder/designator. This upgrade includes navigational, communications, and targeting improvements and quick-change weapons pylons for four Hellfire missiles and other weapons. Another upgrade, known as the Multi-Purpose Light Helicopter configuration, includes equipment kits for cargo, medical evacuation, and troop transport.

With the changing threat, the Army has begun to revise its basic warfighting doctrine. To counter potential regional threats, the evolving AirLand Operations doctrine calls for the rapid deployment of contingency forces and for aircraft operations deep into enemy territory. These threats may involve "non-linear" battlefields and require corps-level intelligence-gathering, target acquisition, and weapons delivery over areas as large as 500 kilometers by 200 kilometers. The Army expects that its aviation element, particularly its attack and armed reconnaissance helicopters, will play a significant combat role on this large battlefield because of their lethality and ability to aggressively pursue the enemy.

The Air Force, however, has traditionally "owned" the airspace envisioned for AirLand Operations. Although the Army and the Air Force have agreed on the Army's proposed AirLand Operations concept, they have yet to agree on how Army aviation will actually operate deep in enemy territory, beyond the Army's fire control line. Disagreements could arise over the use of Air Force aircraft; Army helicopters, including the Comanche; and precision long-range weapons, such as tactical missiles.

Comanche Unit Cost Has Increased, and Continued Cost Growth Is Likely

The Comanche was justified to Congress as a relatively inexpensive aircraft to buy and maintain, but reductions in the planned acquisition quantity, delays in development, and other factors have resulted in increases in the aircraft's estimated unit cost. While the estimated total program cost has declined, the estimated unit cost in escalated dollars has increased 126 percent since 1985 and more than 40 percent since 1988. Future increases in the unit cost also are likely. Engine costs, for example, are expected to grow, and several components under development contain technical risks and the potential for cost increases. Moreover, reductions in the planned acquisition quantity and design changes have reduced anticipated savings in operation and support costs.

Comanche Unit Cost Has Increased As Planned Acquisition Quantity Has Been Reduced

The estimated total program cost for the Comanche has declined in escalated dollars from \$60.6 billion in 1985 to \$35.4 billion in 1991, but the aircraft's estimated unit cost has increased from \$12.1 million to \$27.4 million. In 1988, the estimated program cost totaled \$40 billion, and the unit cost was \$19.1 million.

Total program appropriations through fiscal year 1992 were approximately \$1.8 billion in research, development, test and evaluation funding. The Army has requested \$443 million for fiscal year 1993 to continue research and development. At the time of our review, the total research and development cost was estimated to be \$4.8 billion in escalated dollars. No procurement funds have been appropriated. (See table 3.1.)

Chapter 3
Comanche Unit Cost Has Increased, and
Continued Cost Growth Is Likely

Table 3.1: Comanche Program Costs and Planned Acquisition Quantities

Escalated dollars in millions				
	May 1985	Nov. 1987	June 1988	Oct. 1991 ^a
Program cost				
Cost category				
Research and development	\$3,200	\$5,400	\$3,900	\$4,800
Procurement	57,400	74,300	36,100	30,600
Total	\$60,600	\$79,700	\$40,000	\$35,400
Unit cost	\$12.1	\$18.6	\$19.1	\$27.4
Acquisition quantity				
Mission				
Reconnaissance and attack	3,072	2,128	2,096	1,292
Utility	1,951	2,164	0	0
Total	5,023	4,292	2,096	1,292

^aThe estimated \$1.9 billion cost of the Longbow radar and missile system is excluded.

Source: Comanche Program Manager's Office.

To compare the Comanche's and Apache's unit costs, we converted these costs to 1992 constant dollars. We determined, using these dollars, that the Comanche's unit cost would be \$1.4 million higher than the Apache's unit cost, or \$19.1 million for the Comanche compared with \$17.7 million for the Apache.

Factors Contributing to Unit Cost Growth

The Comanche's unit cost has increased primarily because the planned acquisition quantity has been reduced. A lowered acquisition quantity increases a weapon system's unit cost by spreading program costs across fewer units. The Army had planned to purchase 5,023 aircraft in 1985, but the number was reduced to 1,292 aircraft by 1990. The Secretary of Defense, in reducing the planned acquisition quantity to its current level in August 1990, based his decision on (1) the decline in the Warsaw Pact threat, (2) concerns about the weapon system's affordability, and (3) approved U.S. military force reductions.

When the Secretary of Defense reduced the planned acquisition quantity, he also delayed full-scale development for 2 years until 1995 in order to integrate prototype testing into the acquisition program. The number of prototypes was increased from three to six, and the testing program was extended. The Army's fiscal year 1993 budget request for the Comanche program provides for an expanded research and development phase, which would delay full-scale development beyond 1997, adding to the development costs.

Longbow System Costs Excluded

The Army plans to incorporate Longbow radar and missile systems on about one-third of its Comanche helicopters. This system is expected to enhance the Comanche's ability to detect and destroy tanks and other enemy assets and to operate at night and in bad weather. The total Comanche program cost estimate of \$35.4 billion does not include the \$1.9 billion cost of the Longbow system.

Engine Modification Will Increase Costs

A Comanche program official told us that the aircraft's T800 engine will require a power upgrade of about 12 percent to compensate for increases in the Comanche's weight. The cost for the engine modification, according to this official, is approximately \$200 million over 6 years.

When the demonstration/validation/prototype contract was awarded in April 1991, the Army's empty weight goal for the Comanche was 7,500 pounds, and the engine was designed to power an aircraft weighing up to 8,138 pounds. The Army subsequently determined that it was necessary to increase the engine horsepower to allow for (1) additional equipment, (2) the Longbow system, and (3) possible weight growth. Table 3.2 shows the weight increases associated with the need to increase engine horsepower.

Table 3.2: Weight Increases in the
Comanche

Weight in Pounds	
	Weight
Empty weight	7,500
Equipment	
Pilot floor armor	62
Radar warning receiver and radar frequency interferometer	57
High-frequency radio	25
Radar frequency and infrared counter measures	130
Subtotal	7,774
Longbow system	540
Possible weight growth	300
Total	8,614

The Secretary of Defense's 1990 decision to scale back the planned acquisition quantity and delay the procurement start date voided production and operating cost guarantees in the engine development contract. According to a program official, the Army likely will have to give up favorable contract options on the engine's unit cost. A Comanche

program official said that costs will likely increase as a result but that the amount of the increase is unknown. In addition, any future weight growth could require additional engine modifications and increase costs.

Technical Risks Contain Potential for Cost Increases

Technical risks that remain in the development of the Comanche contain the potential for cost increases. Several of these risks are associated with the mission equipment package (electronic components), which provides navigational, communication, and target acquisition capabilities. The complex software for the mission equipment package is still under development. Hundreds of functions that the software is to perform must be processed and integrated, and some functions have not been defined. If these and other technical risks remaining are not resolved before full-rate production, the contractor team could proceed into production without having developed the Comanche's desired capabilities, resulting in either diminished aircraft capabilities or cost growth from delays and technical revisions. (See ch. 5 for a more detailed discussion of technical risks.)

Operation and Support Cost Savings Are Questionable

Expected savings in the Comanche's operation and support costs are not likely to be realized. The Army justified the Comanche to Congress, in part, on the assertion that the helicopter could be operated and supported for less than 50 percent of the current helicopter fleet's operation and support costs. These savings would result from a reduction in the total number of aircraft in the inventory with the fielding of the Comanche—at a less than one-for-one replacement rate. However, after the 50-percent goal was established, the Army changed the Comanche's design to include a second pilot, increasing personnel costs. In 1988, we reported that the Army had reduced the expected savings for operations and support to an estimated 20 percent of that of the current fleet. Since then, the planned acquisition quantity has been cut an additional 38 percent. As of February 1992, the Army had not developed documentation supporting its claim of a 20-percent savings in the operation and support costs.

Selected Reliability, Availability, and Maintainability Requirements May Be Difficult to Achieve

The Comanche may require more maintenance and be available less often to carry out its missions than the Army anticipates. The Army established a maintenance requirement for the Comanche of 2.6 man-hours for every hour of flight, but this figure may understate the aircraft's actual maintenance needs, given the Comanche's complexity and its dependence on an unproven system designed to automatically detect and correctly isolate mechanical and electronic failures. Understating these needs could result in an understaffed maintenance work force. If this occurs, the Army will have to either add maintenance staff or reduce flying hours. We also found that the Army (1) may be overstating the amount of time the Comanche will be available to carry out its missions because it has not sufficiently accounted for all aircraft downtime associated with scheduled maintenance and (2) excluded operational availability, a key measure of readiness, from the program baseline, which could impede Army and DOD decisionmakers in identifying systemic problems in the aircraft.

Army May Have Underestimated the Comanche's Maintenance Requirement

When the Army established its 2.6-hour maintenance requirement as part of its reliability, availability, and maintainability (RAM) requirements for the Comanche, it considered the number of maintainers available to a battalion of light attack aircraft in the current fleet—that is, the Cobra and Kiowa.¹ Although the Cobra and Kiowa are less complex than the Comanche, their maintenance man-hours are higher than the 2.6 man-hours predicted for the Comanche. The Army Aviation Center reported that the Cobra had a maintenance rate of 10.22 man-hours and the Kiowa had a rate of 3.49 man-hours.

While the Comanche is being designed to be easier to maintain, it contains 76 percent more avionics than the Cobra and has retractable landing gear and internal weapons bays—advanced features that neither the Cobra nor the Kiowa have. In addition, the Comanche's planned wartime flying rate of 2,200 hours per year is significantly higher than the Cobra's approved wartime flying rate of 780 hours or the Kiowa's approved wartime flying rate of 816 hours.

The Army also had used its experience with the Cobra to establish maintenance requirements for the Apache—an aircraft that approximates the complexity of the Comanche. As we pointed out in a September 1990 report, because the Apache was more complex and difficult to maintain

¹RAM requirements influence the design of a weapon system, provide criteria for developing test requirements and assessing test results, and provide a basis for logistic support planning.

than the Cobra, Apache maintenance personnel could not accomplish its maintenance requirement, resulting in reduced flying hours and operational availability.² The Apache's maintenance rate is about 15 man-hours, according to the Army Aviation Center.

Design and Development
Improvements

The Army believes that the design of the Comanche will assist in achieving its maintenance requirement. For example, the Army points out that Comanche has (1) fewer parts than other helicopters, (2) an upgraded electronic architecture to improve reliability, and (3) components that are expected to be easily accessible to maintainers. In addition, according to the Army, maintenance personnel will be able to document, store, and retrieve maintenance and logistic information using a portable computer, and certain tasks associated with the intermediate-level maintenance have been eliminated.

The Army also said its approach to developing the Comanche will enable the aircraft to meet its maintenance requirements. The Army indicated that, in selecting the winning design for the Comanche, it emphasized the aircraft's supportability, which includes such considerations as how easily it could be maintained in the field. In addition, pilots and maintenance personnel are working with engineers of the contractor team to provide their views about the Comanche's requirements.

Studies Showed Maintenance
Requirement of Comanche
May Be Understated

In an April 1990 study, the Office of the Secretary of Defense's Cost Analysis Improvement Group developed an independent estimate of 9.0 maintenance man-hours per flight hour for the Comanche—about 3 times higher than the Army's requirement. The group's estimating methodology involved developing a linear regression of maintenance man-hours versus avionics weight for several Army helicopters. The group then applied a 30-percent improvement factor that allowed for technological advances.

To reconcile the Army's and Cost Analysis Improvement Group's estimates of maintenance man-hours, an Army-wide study of this issue was performed by the Light Helicopter Operating and Support Cost Working Group, which was staffed by Office of the Secretary of Defense and Army

²Apache Helicopter: Serious Logistical Support Problems Must Be Solved to Realize Combat Potential (GAO/NSIAD-90-294, Sept. 28, 1990).

Chapter 4
Selected Reliability, Availability, and
Maintainability Requirements May Be
Difficult to Achieve

representatives. The study concluded that no existing Army data collection system provided comprehensive and accurate data on maintenance work load. The study also stated that the Army's method of developing estimates of maintenance work load for new systems was limited to "direct productive" time—that is, the time spent working on the aircraft. Excluded was time spent obtaining tools and consulting maintenance manuals.

As a result of the study, the Under Secretary of Defense for Acquisition directed the Army in July 1991 to expand its work load data collection system to capture the direct, indirect, and nonproductive activities associated with maintenance. In addition, the Army was directed to continue developing improved methodologies for estimating staffing requirements for systems such as the Comanche. Nevertheless, the Comanche Program Manager's Office believes the 2.6 maintenance man-hour requirement is achievable and does not plan to revise the requirement.

We recommended in November 1991 that the Secretary of Defense direct the Secretary of the Army to revise the Army's definition of maintenance man-hours per flight hour as directed by the Under Secretary of Defense for Acquisition.³ The Army has not yet responded to our recommendation.

Potential Consequence of
Increased Maintenance
Burden

The Army, in its report justifying the Comanche's RAM requirements, stated that if the aircraft exceeds its 2.6-hour maintenance requirement, the current force structure would be unable to maintain the Comanche for the required 2,200 combat flying hours per year.⁴ As a result, the force structure would need to be increased to provide the additional maintainers required, which in turn would increase operation and support costs. If maintainers were not added, the Comanche's flying hours would be reduced.

³Longbow Apache Helicopter: Key Factors Used to Measure Progress in Development Need to Be Changed (GAO/NSIAD-92-43, Nov. 21, 1991).

⁴Comanche Reliability, Availability, and Maintainability Rationale Report, Army Training and Doctrine Command and Army Materiel Command (Nov. 1989).

Limitations of Fault Diagnostic Capabilities Likely to Offset Maintainability Improvements

The Army is relying heavily on the Comanche's fault detection and isolation system to help reduce the maintenance burden. The system is designed to automatically detect and isolate mechanical and electronic problems, cutting down on the time maintenance personnel must spend diagnosing these problems. However, our review of program documents and Army and DOD studies shows that the system may not work as effectively as the Army expects. If the system is unable to meet its required operating levels, the helicopter's maintenance and logistic support time may increase.

According to the Comanche's specifications, the on-board system is to automatically detect 95 percent of all avionics/electronics failures and at least 88 percent of all mechanical/electrical system failures. Of the avionics/electronics failures detected, 98 percent must be correctly isolated. Of the mechanical/electrical system failures detected, not less than 80 percent must be correctly isolated on the first pass with no removals for diagnostic purposes. In addition, the Comanche has a false alarm requirement of no more than 5 percent.

While the Army is assuming this high level of success in the system's operation, a program assessment document evaluated the risk as moderate to high that the Comanche will not achieve its specified fault detection and isolation system values. It also stated that although in-depth information to substantiate the Comanche's target percentages had been supplied, these percentages had not been achieved, especially in the fault isolation and false alarm areas. Moreover, the Comanche's Risk Management Plan assessed the fault diagnostic and isolation system as having a moderate to high risk.

A 1990 Army study that examined the performance of built-in test systems in Navy, Air Force, and Army aircraft concluded that the systems had not proven as reliable as the system designers had estimated and had not resulted in significant savings in maintenance staffing needs as originally predicted.⁵ The study stated that the Army had experienced difficulties with its previous built-in test systems. Not only had these systems failed to meet all performance expectations, they had resulted in increased downtime and more maintenance for the aircraft.

⁵Early Manpower, Personnel and Training Estimation Methods: An Evaluation of the LHX Test-Bed Research Program, Volumes I and II, Army Research Institute for the Behavioral and Social Sciences (Feb. 1990).

With respect to the Comanche, the study cautioned that expectations for the fault detection and isolation system were high and that logistical support planning assumed that the system would be a total success. The study concluded that "although conceptually possible, the overwhelming evidence is that the state-of-the-art of built-in test technology is not sufficiently mature to achieve total success with the hardware." The Army believes that the Comanche's electronics, which are primarily digital, will eliminate many of the reliability and calibration problems associated with earlier systems. However, a 1991 DOD study stated that the embedded diagnostic system envisioned for the Comanche is complex, with over 100 sensors scattered throughout the aircraft, which in turn could create a maintenance burden of its own.

Operational Readiness Objective Unlikely to Be Met

The Army anticipates that the Comanche will be ready to carry out its wartime missions 75 percent of the time, but the aircraft may not meet this operational readiness objective because its reliability requirement was established without considering the downtime associated with scheduled maintenance. The Comanche's reliability requirement is 4.5 hours "mean time between essential maintenance actions," which reflects how often mission-essential equipment needs corrective maintenance. Army guidance shows that mean time between essential maintenance actions is a significant factor in achieving the operational readiness objective—that is, the more time between essential maintenance actions, the more likely operational readiness will be higher.

In its analysis of the Comanche's reliability requirement, the Army excluded scheduled maintenance on the assumption that it would not significantly affect the time the system was unavailable. Scheduled maintenance typically involves systematic inspections and preventive measures to identify potential problem areas. The Army, in contrast, plans to use a new scheduled maintenance concept known as progressive phased maintenance that minimizes inspection requirements, and thus aircraft downtime, by consolidating daily, phased, and special inspections. In addition, scheduled maintenance actions are restructured into increments conducted at specified time intervals. The Comanche has an inspection cycle of 480 flight hours, during which a portion of the aircraft will be inspected in each of eight 60-flight-hour increments.

Army regulations, however, indicate that scheduled maintenance should be included in operational readiness calculations. In addition, an Army report on progressive phased maintenance showed that while this approach

reduced scheduled maintenance time, it did not eliminate it.⁶ Further, the Army's RAM Rationale report indicated that 44 percent of maintenance man-hours would be expended on scheduled maintenance. The contractor team reported that the Army's use of progressive phased maintenance in general had resulted in a greater maintenance burden imposed at the user level or an increased amount of deferred maintenance.

A program official told us he believes it will be possible to return the Comanche to a ready condition within 2 hours, as allowed by Army regulations. However, he could offer no support for that position. It should be noted that the Army also has been unable to return Apache helicopters to a ready condition within the allotted time for scheduled maintenance, thereby reducing the aircrafts' availability.

Operational Availability Requirement Excluded From Program Baseline

Operational availability, a key performance measure connected with operational readiness, has been excluded from the Comanche's program baseline. A program baseline consists of cost, schedule, and performance parameters critical to the success of a system. These parameters can include both technical requirements (cruise speed, weight, and rate of climb) and operational effectiveness requirements (the probability of detecting and classifying targets). Each baseline parameter consists of an objective or desired capability and a threshold or minimum capability. The program manager is required to notify the DOD Acquisition Executive, the Secretary of the Army, and the Army Acquisition Executive if a cost, schedule, or performance parameter in the baseline is not met.

According to Army guidance, operational availability is a function of operational reliability and maintainability, the logistic support system, and the system usage rate; thus, it is a key measure of performance. Excluding operational availability from the program baseline could impede the ability of Army and DOD decisionmakers to identify systemic problems in the Comanche. In the case of the Apache, for example, the aircraft met or nearly met its reliability and maintainability requirements; however, its operational availability rates indicated underlying systemic problems relating to frequent failures of components and the resulting demand for maintenance.

⁶Force Development Test and Experimentation of Progressive Phased Maintenance (1987).

Conclusions

Given the complexity and required flying rate of the Comanche, the disparity between the Army and DOD estimates of maintenance man-hours per flight hour, and the dependence on an unproven fault detection and isolation system, we believe that the aircraft is unlikely to achieve its maintenance requirement of 2.6 maintenance man-hours for every flight hour. If the Comanche fails to achieve this maintenance requirement, it would require either additional maintainers, resulting in increased operation and support costs, or a reduction in planned flying hours. In addition, the Comanche may not achieve its operational readiness objective because of an understated reliability requirement. Finally, by including the operational availability requirement in the program baseline, Army and DOD decisionmakers could have greater assurance that any systemic problems in the aircraft are identified. This action would be especially appropriate considering the uncertainty surrounding the Comanche's maintenance and reliability requirements.

Recommendations

Should DOD decide to continue with the Comanche program, we recommend that the Secretary of the Army take the following actions:

- Revise the Comanche's maintenance man-hour per flight hour requirement to include, as directed by the Under Secretary of Defense for Acquisition, all time related to maintenance work on aircraft. This would provide a realistic basis for determining how many maintainers will be required to support the aircraft.
- Include scheduled maintenance in the Army's analysis of the Comanche's reliability requirement.
- Add the operational availability requirement to the Comanche's program baseline.

Acquisition Strategy Considered Innovative, but Risks Remain

The Army's acquisition strategy for the Comanche is a departure from traditional acquisition programs. It provides the contractor team significant flexibility in making trade-offs in the Comanche's desired capabilities to meet basic weight and cost goals. With primary responsibility for developing the aircraft and integrating components, the contractor team is to determine whether desired capabilities are achievable and, if so, what technological approaches to employ. At the time of our review, the planned overlap between development and production in the Comanche's acquisition schedule meant that production could have started before substantive technical risks were addressed. It is uncertain whether any concurrency exists in the February 1992 restructuring of the program.

Acquisition Strategy Provides Contractor Team Significant Latitude in Meeting Goals

The Army's acquisition strategy for the Comanche, which implements a DOD policy that provides for streamlining acquisition programs through innovative approaches, differs considerably from most acquisition programs. Traditionally, DOD acquisition programs established a large number of specific requirements and did not permit trade-offs in desired capabilities to meet the requirements. In contrast, the Army's acquisition strategy for the Comanche allows the contractor team to design and develop the aircraft with a limited number of goals. The Army has directed the team to develop an aircraft (1) with an empty weight goal of 7,774 pounds, (2) with a "flyaway" cost goal of \$9.3 million,¹ and (3) that uses twin T800 engines.²

To achieve these goals, the contractor team is permitted design flexibility as long as performance stays within mutually agreed-upon ranges. The Army and contractor team have reached agreements on performance ranges in areas such as radar detectability, crashworthiness, ballistic tolerance, flight performance, and combat empty weight. According to the Army, flexibility within these ranges provides opportunities for cost savings and reduced program risk, with minimum impact on the Comanche's capabilities.

While the contractor team has design flexibility within certain performance ranges, it may lose award fees if desired capabilities fall below the performance ranges. Conversely, the contractor may earn the maximum

¹The Army uses flyaway cost as a cost-estimating and measurement mechanism. Flyaway cost is considerably less than the unit cost because it does not include all procurement costs.

²The Comanche's weight and cost goals have changed several times since its development began. The previous empty weight goal was 7,500 pounds, and the cost goal was \$8.5 million.

award fee by optimizing the balance among the following factors: technical performance, supportability, producibility, and life-cycle cost. In addition, the contractor team is to share the costs of overruns with the Army as an incentive to control costs, and the contractor team has agreed to fix all failures during development and, as necessary, to use a percentage of production profits to correct reliability problems.

Contractor Team Has Not Achieved All Desired Capabilities

In the process of meeting the weight and cost goals established by the Army, the contractor team has identified several desired capabilities that cannot be achieved. As a result, the Comanche Program Manager's Office has revised desired capabilities in the following areas to correspond to what the contractor team believes it can achieve:

- aircraft crashworthiness,
- radar cross-section detectability levels,
- horizontal and vertical field of view of the night vision system and television sensor, and
- armor density and coverage for protection of the crew from small arms fire.

The changes to these desired capabilities are not major, according to program management officials. The Army's approval of a less stringent crashworthiness standard, for example, means that the aircraft is likely to sustain a higher amount of damage upon crashing. Other trade-offs are possible until the operational capability document is approved. Approval is scheduled for August 1995 but could come later based on the Army's restructuring of the Comanche program to extend the research and development phase.

Acquisition Plan Extended, but Concurrency Remained

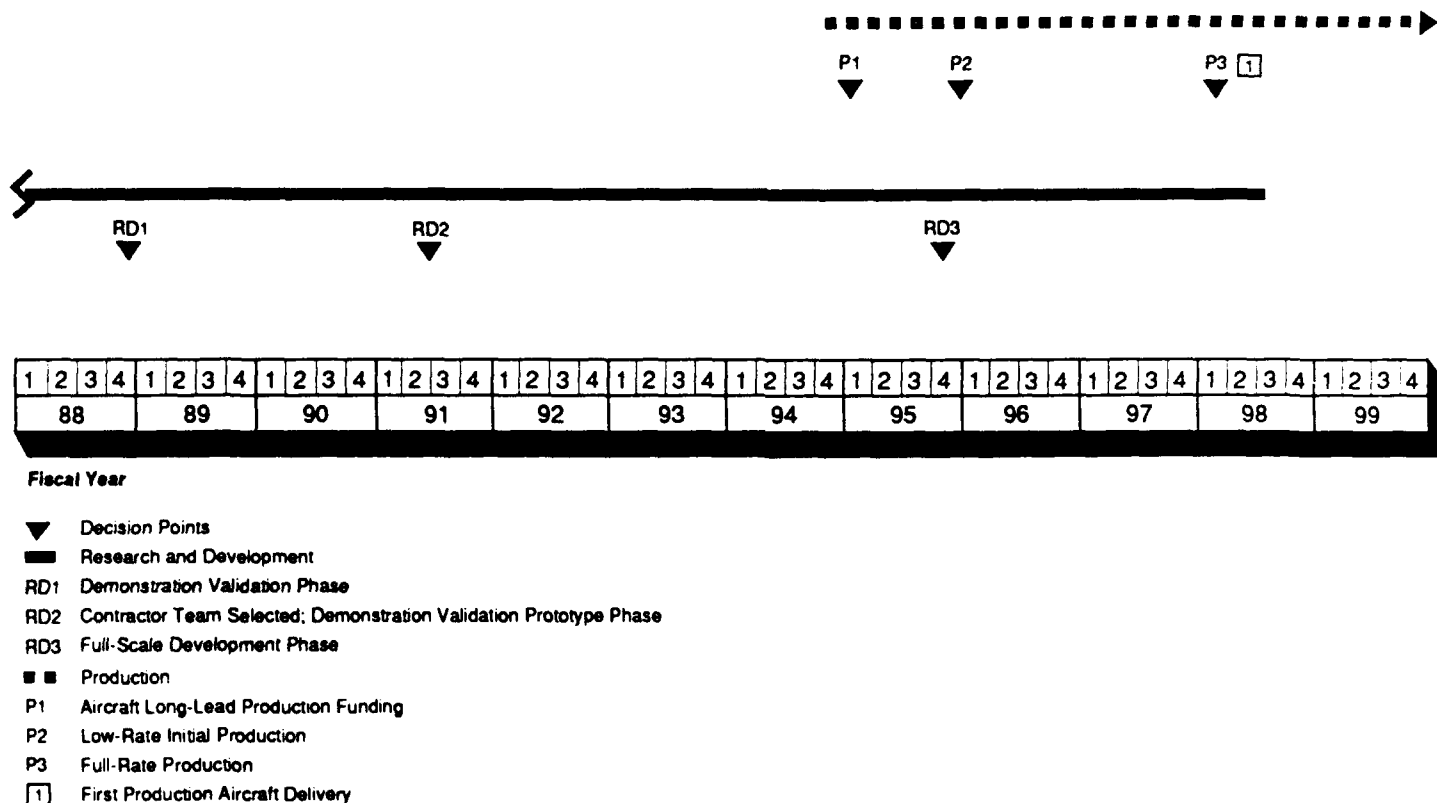
The Secretary of Defense's 1990 decision to delay full-scale development for 2 years and to integrate prototype testing into the development schedule eliminated some of the concurrency and risks in the acquisition program. However, at the completion of our fieldwork, the Army planned to start producing the Comanche 2 years before full-scale development and prototyping were completed. In the past, Army weapon systems have often experienced schedule delays, technical difficulties, budgetary constraints, and performance or configuration problems during development. When such problems arose, the weapon systems were sometimes produced before development and testing were completed and required modification or retrofitting.

**Program Acquisition
Schedule Revised in August
1990**

Following a Major Aircraft Review, the Secretary of Defense in August 1990 directed that the Comanche acquisition schedule be revised to extend the development phase 2 years, integrate prototype testing prior to full-scale development, and plan for a minimum procurement of 1,292 aircraft. This schedule included a total of six prototype aircraft,³ with the first flight scheduled for August 1994. The stretch-out of the development was partially due to the reduction in the Warsaw Pact threat, which meant that DOD did not have to rush a weapon system to production in order to meet an urgent fielding deadline. Figure 5.1 shows the acquisition schedule at the time of our review.

³The Army's February 1992 restructuring of the Comanche program reduced the number of prototypes from six to three.

Figure 5.1: Comanche Acquisition Schedule (as of October 1991)



Source: U.S. Army

Concurrency in Acquisition Schedule

In an April 1990 report to several Senate and House committees and subcommittees on concurrency associated with the development of major weapon systems, the Under Secretary of Defense for Acquisition stated that programs with a high degree of concurrency typically proceed into low-rate initial production before significant initial operational test and evaluation is completed. According to Army regulations, this testing, conducted during full-scale development, is to determine the utility, effectiveness, and operational suitability of a weapon system using Army personnel in a realistic and operational environment.

For the Comanche program, low-rate initial production was to begin in October 1996, whereas initial operational test and evaluation was not to

end until almost 2 years later. A Comanche program official told us that because initial operational test and evaluation results would be unavailable until September 1998, any serious problems that the testing revealed could adversely affect the first 24 low-rate initial production aircraft. Further, the Army's acquisition plan scheduled the testing of software to be completed in September 1998, after 72 Comanche aircraft were to have been put on contract. Finally, concurrency would have occurred because the first production delivery was scheduled for February 1998, 7 months before initial operational test and evaluation was to be completed in September 1998.

Technical Risks Remain in Comanche Development

The Comanche acquisition strategy has included several risk reduction and engineering demonstration efforts to reduce the technical risk associated with developing and producing the aircraft's high-technology components and systems. The Comanche Program Manager's Office, before proceeding to the demonstration/validation phase of development, used laboratory demonstrations to show the feasibility of a number of high-risk components, such as the electro-optical targeting system and the mission equipment package (electronic components). The focus of the demonstration/validation phase that began in 1988 was to define the mission equipment package and performance requirements through design analyses and demonstrations. The demonstration/validation phase included

- laboratory demonstrations of the mission equipment package components, such as the target acquisition system, television sensor, and mission computer;
- flight and laboratory demonstrations of the night vision system and helmet-mounted display;
- wind tunnel tests of the aircraft design;
- laboratory demonstrations of the infrared suppressor; and
- engineering simulations to examine flight controls, air vehicle handling qualities, and combat effectiveness.

Although some progress was made through these risk reduction efforts, technical risks remain for the Comanche program. According to the Office of the Secretary of Defense, Source Selection Evaluation Board, and Comanche program officials, the remaining risks contain a medium degree of risk, which generally indicates some demonstrated capability but not the expected capabilities of fully integrated technology. Table 5.1 shows some of the risks associated with the Comanche program.

Table 5.1: Risk Areas Associated With Comanche Development

Risk area	Function	Areas of concern	Effect of not achieving desired capability
Mission equipment package (electronic components)	Provides navigational, communication, target acquisition, and other capabilities.	Insufficient time allotted to incorporate and integrate components.	Without this equipment, capabilities would be significantly reduced.
Computer software for the mission equipment package	Required to automatically detect and classify targets.	Not all aspects have been developed; could produce excessive false alarm rates.	Without this software, mission effectiveness would be reduced.
Capability to produce liquid crystal displays	Cockpit display screens that show various mission data.	Not compatible for video presentations with images from the forward-looking infrared sensor.	Reverting to existing technology would reduce capability and add to space and weight requirements.
Producibility, tooling, and test capabilities for focal plane array	Image detection for the forward-looking infrared sensor.	Requirements are extensive, and no manufacturer may meet specifications or production quantities.	A less capable system would degrade the aircraft's capabilities.
On-board fault detection and isolation system	Detect and locate both mechanical and electrical system failures.	Reliability levels in this system may not be achievable.	Increased maintenance and logistical delays may occur.

Source: Various DOD and Army officials.

In addition, these same officials told us that the following technical areas contain a medium degree of risk: (1) gun accuracy, (2) crashworthiness, (3) vulnerability to small arms fire, and (4) the contractors' ability to manufacture composite components in the quantities required for production.

Conclusions

The Army has provided the contractor team significant latitude in making trade-offs in the Comanche's desired capabilities to meet basic weight and cost goals. The team has made several trade-offs, and others are possible. The Army believes that this flexibility will enable the contractor team to deliver a technologically advanced aircraft that meets desired operating capabilities.

At the completion of our fieldwork, the acquisition schedule contained concurrency between full-scale development and initial low-rate production. This concurrency increases the risk that some of the initial

aircraft may have unresolved technical problems. If this happens, these aircraft may have to be modified or retrofitted at significant additional cost. Eliminating this concurrency could be an important step in significantly reducing additional costs to modify some aircraft. The Army's restructured Comanche program, with its extension of the research and development phase, could reduce some concurrency.

Recommendation

Should DOD decide to continue with the Comanche program and if concurrency remains in the restructured program, we recommend that the Secretary of the Army eliminate concurrency to the extent practicable to avoid the additional cost of modifying initial production aircraft.

Conclusions and Recommendation

Conclusions

After 10 years in development, the Comanche helicopter is not the low-cost helicopter originally justified to Congress. While reductions in the planned acquisition quantity have reduced the estimated total program cost, the aircraft's estimated unit cost in escalated dollars has risen 126 percent since 1985 to \$27.4 million in 1991. The Comanche, in short, has become the Army's most expensive aviation acquisition program ever. Future increases in the T800 engine unit cost are anticipated, and unresolved technical risks also contain the potential for cost growth. Moreover, projected savings for the Comanche's operation and support costs, compared with the helicopters it is to replace, appear to have become less probable, and the Army has not documented these savings since 1988.

Although the attack mission has always been part of the Army's plans for the Comanche, its lethality is now expected to rival or surpass that of the Apache attack helicopter—blurring the distinction in roles between these two aircraft. Further blurring these roles was the Army's use of the Apache attack helicopter during Operation Desert Storm to conduct long-range armed reconnaissance, which is expected to be one of the Comanche's missions.

The current ambiguity about the role of the Comanche can be traced in part to the Army's focus on its attack capabilities. For example, the Army, in 1987, switched from a single-seat to a two-seat helicopter, in part, because a copilot/gunner was seen as necessary to handle all the demands of the aircraft's attack capabilities. This decision also had the effect of significantly increasing the aircraft's weight and its operational costs. More recently, the Army's decision to incorporate the Longbow system on about one-third of the Comanches will increase not only the helicopter's lethality, but its weight and cost as well.

The Army's need for the Comanche has become questionable by recent developments outside the program. Most significant perhaps is the change in threat from what the Comanche was originally expected to meet—the Soviet and Warsaw Pact threat. No longer is this threat seen as the primary danger facing U.S. forces.

Related to the change in the threat is the reduction of U.S. defense forces. By 1995, the year in which the Comanche was to enter into full-scale development, the active duty strength is projected to be reduced by 500,000. Defense spending is similarly expected to decline. The President's fiscal year 1993 budget request proposes a \$50 billion decrease in military spending over the next 5 years, while some lawmakers

are proposing deeper cuts. Such funding reductions suggest that the competition for research, development, and procurement funds will drastically increase. According to the Congressional Budget Office, the Comanche would require \$2 billion annually during its peak production years.

As part of defense force reductions, the Army is planning to reduce its helicopter fleet, while modifying many of those that will remain to increase their combat capabilities. The arming of the Kiowa, the planned improvements to the basic model Apaches, and the planned Longbow modifications for 227 Apaches raise questions about the need to purchase the Comanche. Its addition to the Army's helicopter fleet, in combination with these planned upgrades, represents an unprecedented increase in Army aviation attack capabilities and lethality.

We believe that changes both within and outside the Comanche program make this an appropriate time to assess the program's viability in order to ensure that the Army still has a valid requirement for acquiring this aircraft. Such a reassessment should address the following questions:

- Given the Comanche program's estimated cost of \$35.4 billion and its likely cost increases while future defense spending is projected to be sharply curtailed, can the Army realistically afford to buy and support the Comanche? Does the Army have an alternative plan should the Comanche prove to be too expensive?
- If the Army does not plan to buy the Comanche, is there a need to continue some or all of the ongoing Comanche research and development efforts?
- Given the Army's reported successful performance of Apaches during Operation Desert Storm, could the Apache and Kiowa helicopters, with upgrades, meet part or all of the future attack and reconnaissance threats, and if so, would this obviate the need for some or all of the Comanches?
- Is the Army now considering viable, low-cost alternatives, such as unmanned aerial vehicles, that could meet part or all of the Army's reconnaissance requirements?
- In light of the now defunct Soviet and Warsaw Pact threat, how does the Comanche's projected advanced capabilities and lethality affect the Army's requirements for (1) upgrades to other Army aircraft, (2) other new aircraft, (3) other Army combat systems, and (4) Air Force close air support and reconnaissance aircraft?
- How will the Comanche be incorporated into the Army's evolving warfighting doctrine, especially in light of possible conflicts with the Air

Force over air operations deep into enemy territory? If these conflicts go unresolved, will that affect the Army's requirements for the Comanche?

- If the Army proceeds with its development of the Comanche helicopter, will it be able to fund its other identified aviation requirements, including the need to replace its aging utility helicopters? What requirements exist for a follow-on to the Apache and will fielding the Comanche change those requirements?

Recommendation

We recommend that the Secretary of Defense review the appropriateness of the Army's requirements for the Comanche program, especially in light of the rising unit cost, dwindling defense resources, diminished threat, the blurring of its distinct role with the Apache, and proposed upgrades to the existing helicopter fleet.

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